VISUAL MANAGEMENT FOR DECISION ANALYSIS

Alessio Ishizaka
Centre for Operational Research and Logistics,
Portsmouth Business School, University of Portsmouth,
Portsmouth PO1 3DE,
United Kingdom
Alessio.Ishizaka@port.ac.uk

ABSTRACT

Visual management has been recently recognized as an excellent way to convey decisions in a clear and convincing way. AHP already used visual techniques for evaluating the pairwise comparisons and performing a sensibility analysis. In this paper, we introduce a new descriptive tool GAIA that can be coupled with AHP in order to visualize the entire problem on a unique plane.
https://doi.org/10.13033/ijahp.v9i1.475

Keywords: Visual management; GAIA; descriptive tool

1. Introduction

It is well-known today that the Analytic Hierarchy Process (AHP) is an extremely useful method. Several reviews have compiled their success stories (Zahedi 1986; Golden, Wasil et al. 1989; Shim 1989; Vargas 1990; Saaty & Forman 1992; Forman & Gass 2001; Kumar &Vaidya 2006; Omkarprasad & Sushil 2006; Ho 2008; Liberatore & Nydick 2008; Sipahi & Timor 2010; Dung, Luan et al. 2016). In this paper, we argue that the usefulness of AHP can be enhanced with visual management techniques. Visual techniques have long been used in AHP for evaluating the pairwise comparisons (

Figure *1*) and performing a sensibility analysis (

Figure *2*). They have been integrated into the main software that supports AHP, and greatly facilitated the decision-making process (Ishizaka & Labib 2009). However, visual techniques cannot only facilitate the decision-making process but can also be used as a descriptive tool that explains the whole problem (Nemery, Ishizaka et al. 2012). In the next section, we present GAIA, a method that was first coupled with AHP by Ishizaka and Siraj et al. (2016).

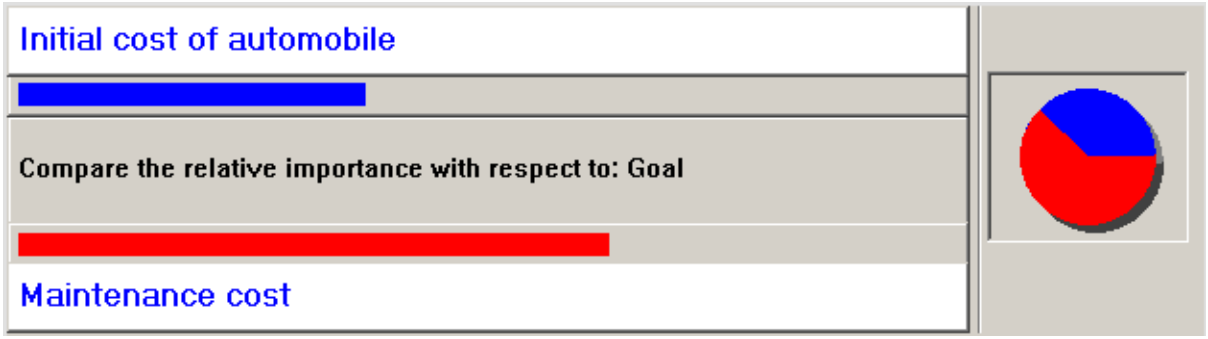

Figure 1. Graphical scale

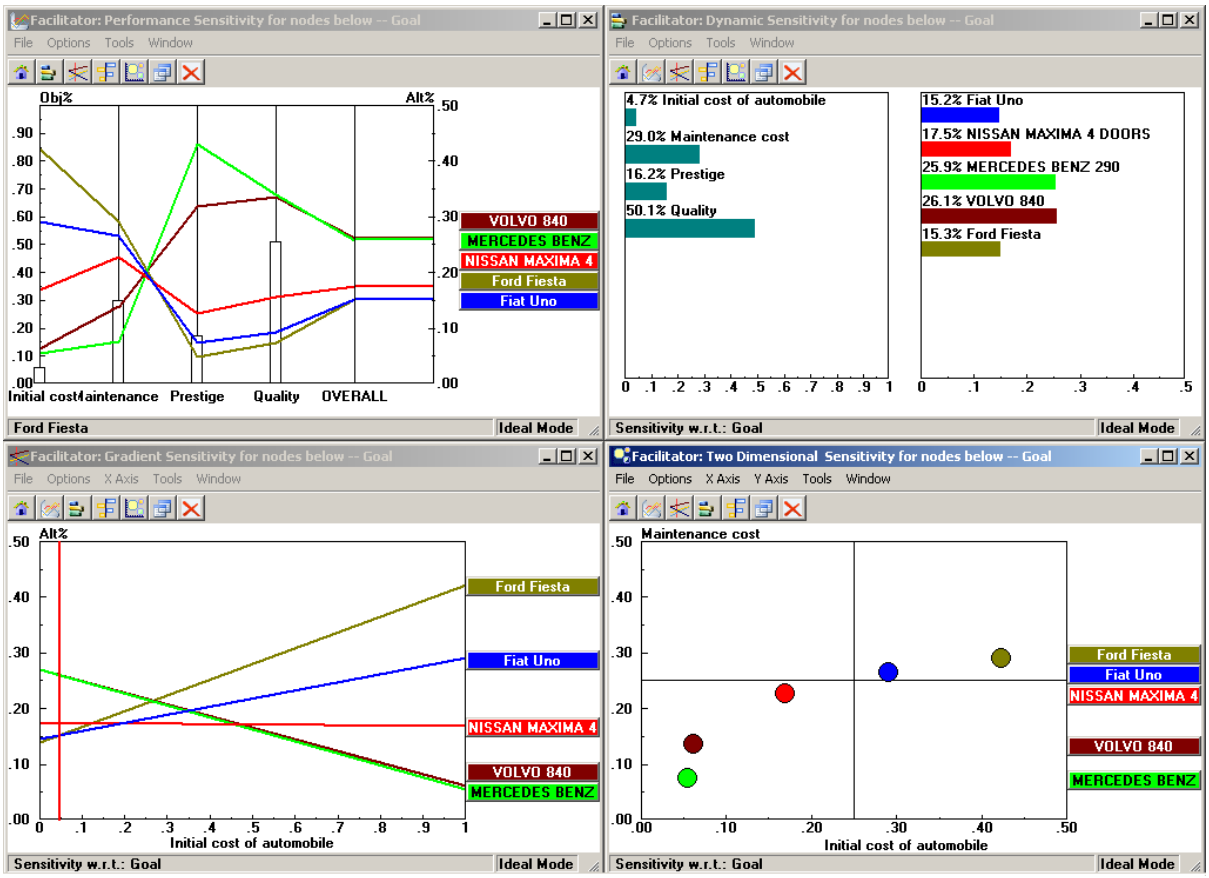

Figure 2. An example of four possible graphical sensitivity analyses in Expert Choice

2. Graphical Analysis for Interactive Aid (GAIA)

The idea of GAIA is to visualise on a plane as much information as possible related to a problem (Mareschal & Brans 1988). For this purpose, we can use the dimensionality reduction technique of the principal component analysis (PCA). The PCA is applied on the local priorities of AHP entered in a matrix. Data are displayed on a plane with the two axes having the maximal and next-to-maximal dispersions

(Collins, Ishizaka et al. 2017). These two axes correspond to the first two principal components.

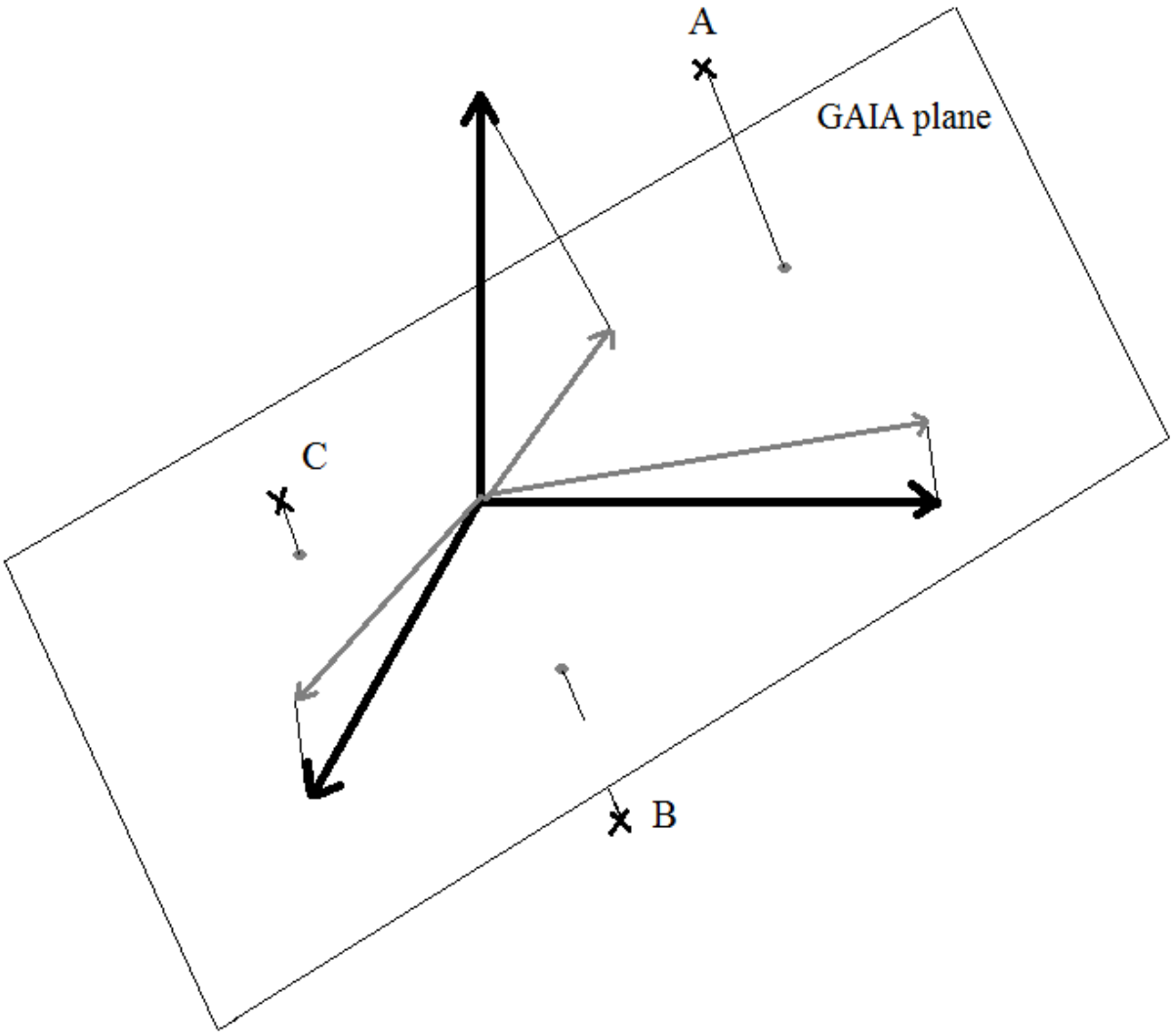

Figure 3. GAIA plane

3. Interpreting the GAIA plane

An illustrative example of a GAIA plane with more than two criteria is given in Figure 4, where the criteria are represented by four vectors (see blue arrows emanating from centre) and the alternatives are represented by dots. The decision stick (labelled as DMG) represents the performance direction taking into account all criteria. The reading is done by projection on the relevant arrow. For example, alternative 3 is the best performing alternative overall, but on criterion 4, alternative 1 is the best.

An angle between two vectors represents the degree of correlation between the two criteria, i.e. the smaller the angle between the two arrows, the more correlated they

are. For example, criterion 1 and 2 are closely correlated, but criterion 3 and 4 have an almost negative correlation. Finally, if alternatives are close, they have a similar level of performance on the different criteria (e.g. alternative 2 and 4).

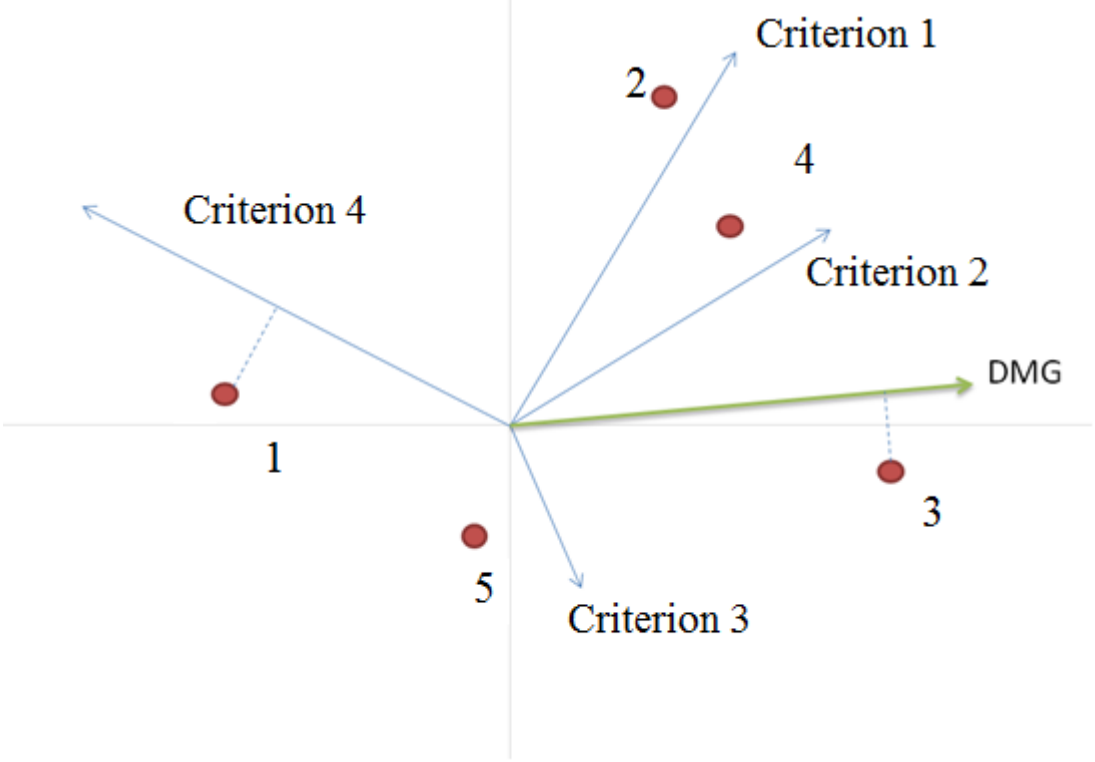

Figure 4. Example of the obtained GAIA graph

4. Conclusion

A multi-criteria decision making method can only be helpful if the decision-maker understands the reasons underpinning the prescribed results. Otherwise, she and/or her team will not accept the results, and it will end in unproductive change management resistance. Visual management is a tool that has long been helpful in structuring the problem, eliciting the pairwise comparisons and analyzing the sensitivity of the ranking. This paper presented GAIA, which allows for the whole problem to be visualized on a unique page. In my consulting experience, a picture has always been the best way to explain results. I strongly believe that AHP will become even more popular if it is used in correlation with GAIA.

REFERENCES

Collins, A., A. Ishizaka, et al. (2017). Film production incentives, employment transformation and domestic expenditure in South Africa: visualizing subsidy effectiveness. *International Journal of Cultural Policy* advance online publications., 1-14. Doi: doi.org/10.1080/10286632.2016.1255206.

Dung, T., N. Luan, et al. (2016). The analytic approach in green supplier selection: a literature review. *ARPN Journal of Engineering and Applied Sciences, 11(11),* 6754-6762.

Forman, E. and S. Gass (2001). The Analytic Hierarchy Process – An exposition. *Operations Research, 49(4),* 469-486. Doi: http://dx.doi.org/10.1287/opre.49.4.469.11231

Golden, B., E. Wasil, et al. (1989). The Analytic Hierarchy Process: Applications and studies. Heidelberg: Springer-Verlag. Doi: 10.1007/978-3-642-50244-6_3

Ho, W. (2008). Integrated analytic hierarchy process and its applications - A literature review. *European Journal of Operational Research, 186(1),* 211-228. Doi: http://dx.doi.org/10.1016/j.ejor.2007.01.004

Ishizaka, A. and A. Labib (2009). Analytic Hierarchy Process and Expert Choice: benefits and limitations. *OR Insight, 22(4),* 201–220. Doi: 10.1057/ori.2009.10

Ishizaka, A., S. Siraj, et al. (2016). Which energy mix for the UK? An evolutive descriptive mapping with the integrated GAIA-AHP visualisation tool. *Energy 95,* 602–611. Doi: http://dx.doi.org/10.1016/j.energy.2015.12.009

Kumar, S. and O. Vaidya (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research, 169(1),* 1-29. Doi: http://dx.doi.org/10.1016/j.ejor.2004.04.028

Liberatore, M. and R. Nydick (2008). The analytic hierarchy process in medical and health care decision making: A literature review. *European Journal of Operational Research, 189(1),* 194-207. Doi: http://dx.doi.org/10.1016/j.ejor.2007.05.001

Mareschal, B. and J.-P. Brans (1988). Geometrical representations for MCDA. *European Journal of Operational Research, 34(1),* 69-77. Doi: https://doi.org/10.1016/0377-2217(88)90456-0

Nemery, P., A. Ishizaka, et al. (2012). Enriching descriptive information in ranking and sorting problems with visualizations techniques. *Journal of Modelling in Management, 7(2),* 130-147. Doi: http://dx.doi.org/10.1108/17465661211242778

Omkarprasad, V. and K. Sushil (2006). Analytic hierarchy process: an overview of applications. *European Journal of Operational Research, 169(1),* 1-29. Doi: http://dx.doi.org/10.1016/j.ejor.2004.04.028

Saaty, T. and E. Forman (1992). The Hierarchon: A Dictionary of Hierarchies. Pittsburgh: RWS Publications. Doi: 10.1007/978-1-4612-5443-0_11

Shim, J. (1989). Bibliography research on the analytic hierarchy process (AHP). *Socio-Economic Planning Sciences 23(3), 1*61-167. Doi: https://doi.org/10.1016/0038-0121(89)90013-X

Sipahi, S. and M. Timor (2010). The analytic hierarchy process and analytic network process: an overview of applications. *Management Decision, 48(5),* 775-808. Doi: http://dx.doi.org/10.1108/00251741011043920

Siraj, S., L. Mikhailov, et al. (2013). PriEsT: an interactive decision support tool to estimate priorities from pairwise comparison judgments. *International Transactions in Operational Research, 22(2),* 217–235. Doi: 10.1111/itor.12054

Vargas, L. (1990). An overview of the analytic hierarchy process and its applications. *European Journal of Operational Research, 48(1),* 2-8. Doi: https://doi.org/10.1016/0377-2217(90)90056-H

Zahedi, F. (1986). The analytic hierarchy process: a survey of the method and its applications. *Interface, 16(4),* 96-108. Doi: http://dx.doi.org/10.1287/inte.16.4.96